



A National Web Conference on the Role of Health IT to Improve Medication Management

Presented by:

Karen Farris, PhD

Jeffrey Schnipper, MD, MPH, FHM

Margie Snyder, PharmD, MPH, FCCP

Moderated by:

Commander Derrick Wyatt

Agency for Healthcare Research and Quality

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Agenda

- Welcome and Introductions
- Presentations
- Q&A Session With Presenters
- Instructions for Obtaining CME Credits

Note: After today's Webinar, a copy of the slides will be emailed to all participants.

Presenter and Moderator Disclosures



Karen Farris, PhD
Presenter



Jeffrey Schnipper, MD
Presenter



Margie Snyder, PharmD
Presenter



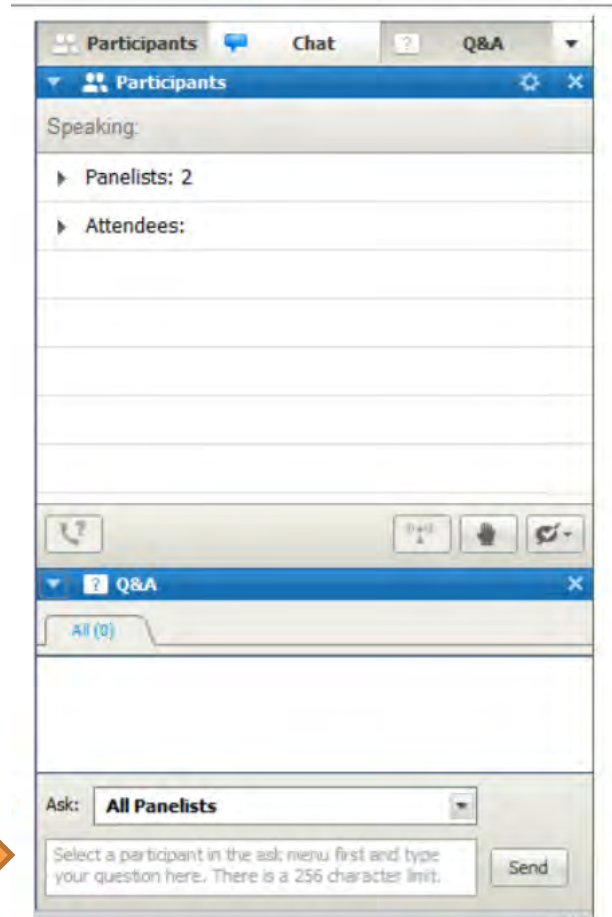
Derrick Wyatt
Moderator

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- PESG, AHRQ, TISTA, and RTI staff, as well as planners and reviewers, have no financial interests to disclose.
- Commercial support was not received for this activity.
- Dr. Snyder has no financial interests to disclose.
- Dr. Farris is a consultant for QuiO.
- Dr. Schnipper is a Principal Investigator for a study sponsored by Mallinckrodt Pharmaceuticals.

How to Submit a Question

- At any time during the presentation, type your question into the “Q&A” section of your WebEx Q&A panel.
- Please address your questions to “All Panelists” in the drop-down menu.
- Select “Send” to submit your question to the moderator.
- Questions will be read aloud by the moderator.



Learning Objectives

At the conclusion of this activity, participants should be able to:

1. Explain the benefits and challenges for using reinforcement learning-guided text messaging to impact medication adherence.
2. Discuss the evaluation of a smart pillbox used by patients during care transitions.
3. Describe the extent to which clinical decision support for community pharmacist-delivered medication therapy management (MTM CDS) aligns with established human factors principles.
4. Discuss the usability and usefulness of MTM CDS for community pharmacists.

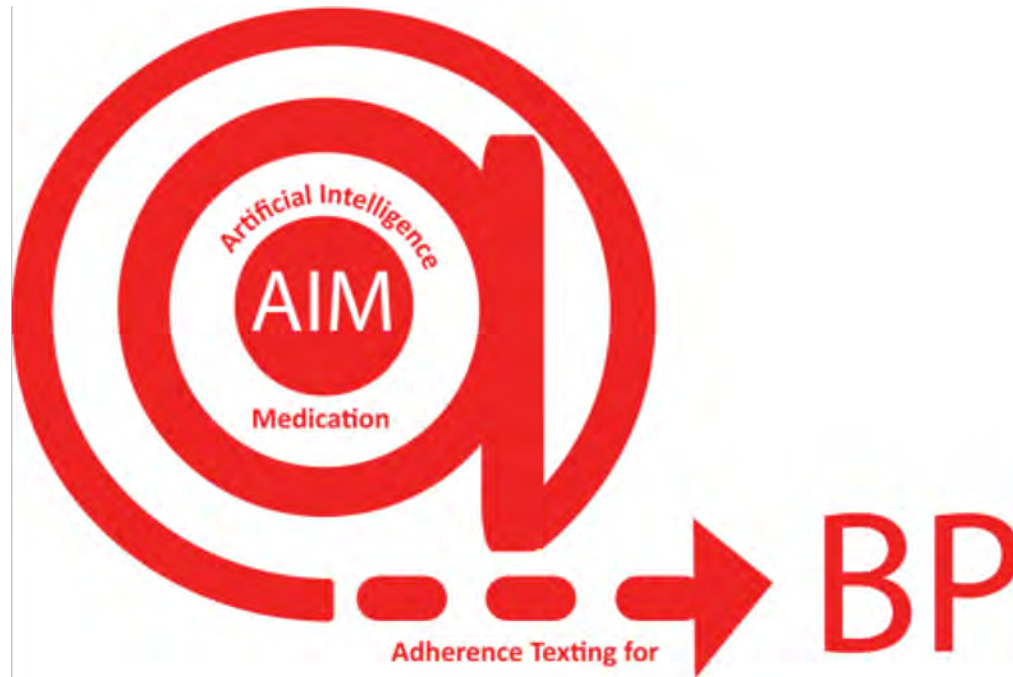


mHealth Technology to Improve Medication Adherence: An RL Agent and Anti-Hypertensives

Karen B. Farris, PhD
Charles R Walgreen III Professor
University of Michigan
Chair, Department of Clinical Pharmacy,
College of Pharmacy



Study Support



- M-Cubed, Provost Office
- MICHR Pilot Grant UL1TR000433
- AHRQ Grant R21 HS022336

Background

- 33-50% of patients do not take their medications properly, contributing to \$290 billion in healthcare costs.
- ~30% of patients have uncontrolled hypertension despite treatment.
- SMS interventions can improve patients' medication adherence.
- mHealth interventions may be limited in their ability to engage patients effectively *over time*.

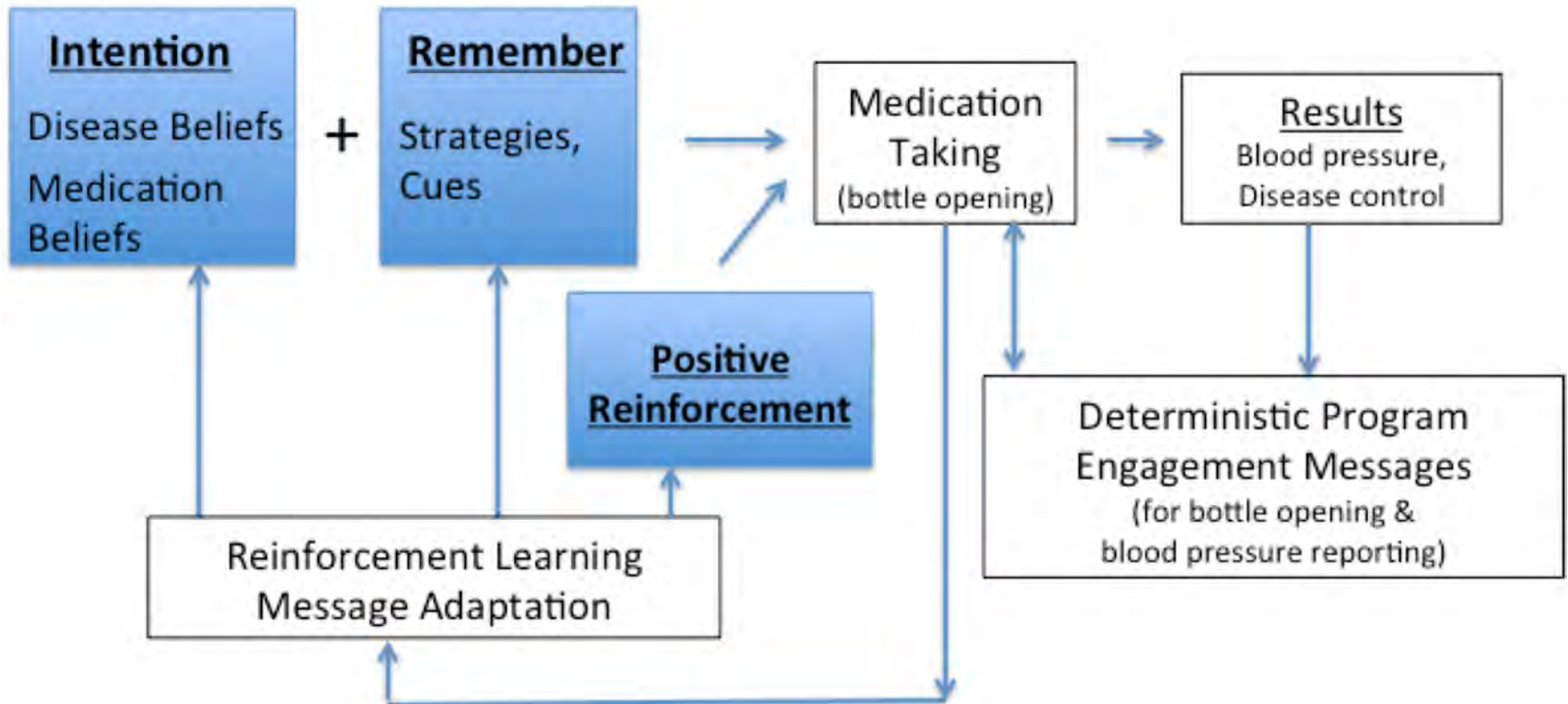


Objective

Apply artificial intelligence (AI) methods, specifically reinforcement learning (RL; one type of AI), to develop a medication adherence system that can automatically adapt text messages to improve individual medication taking.

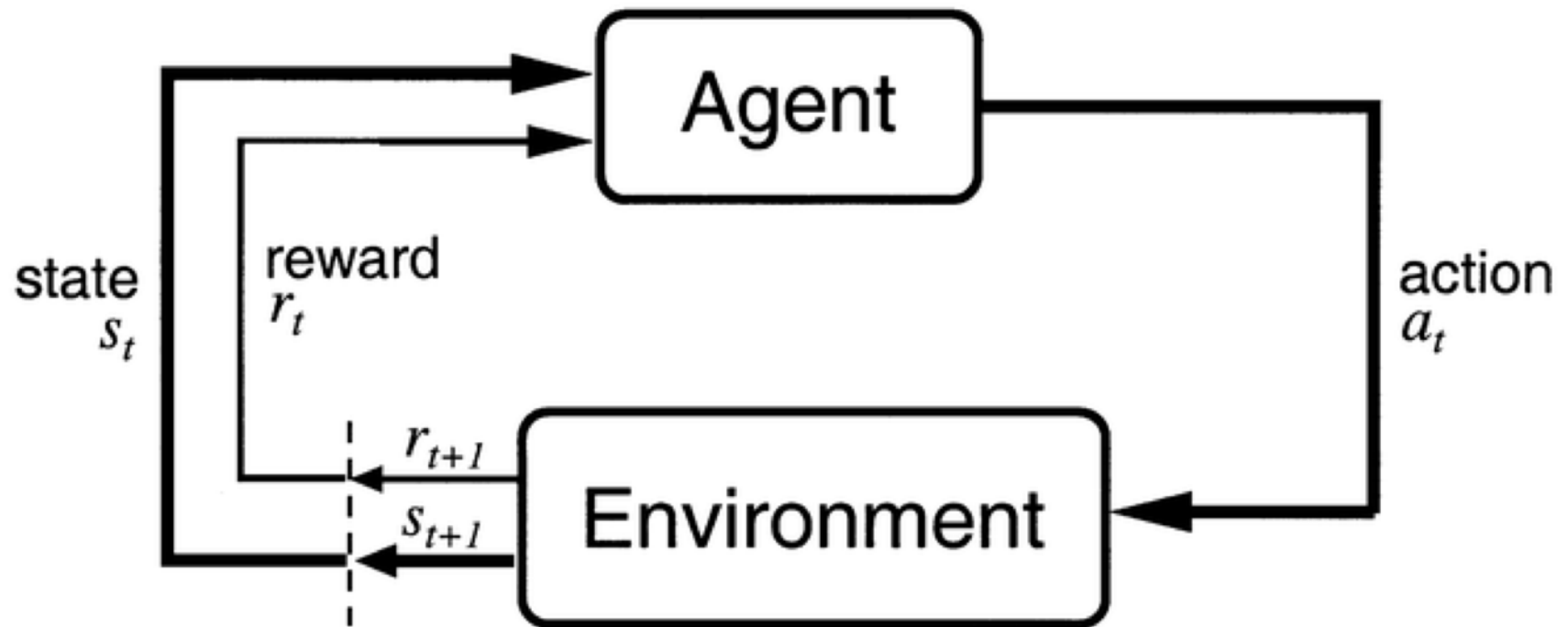
Two Studies

- **Study 1**, Prospective single group trial n=19; subjects used anti-hypertensive, used texting, had Internet; data collection: adherence behavior—self-report and bottle openings.
- **Study 2**, RCT, prospective trial n=50; subjects in Priority Health plan with **anti-hypertensive PDC<0.5 in past year**, used texting, had Internet; data collection: adherence behavior—self-report, bottle openings, and Rx claims.



RL Medication Adherence System

Adapted text messages via Reinforcement Learning, a form of Artificial Intelligence



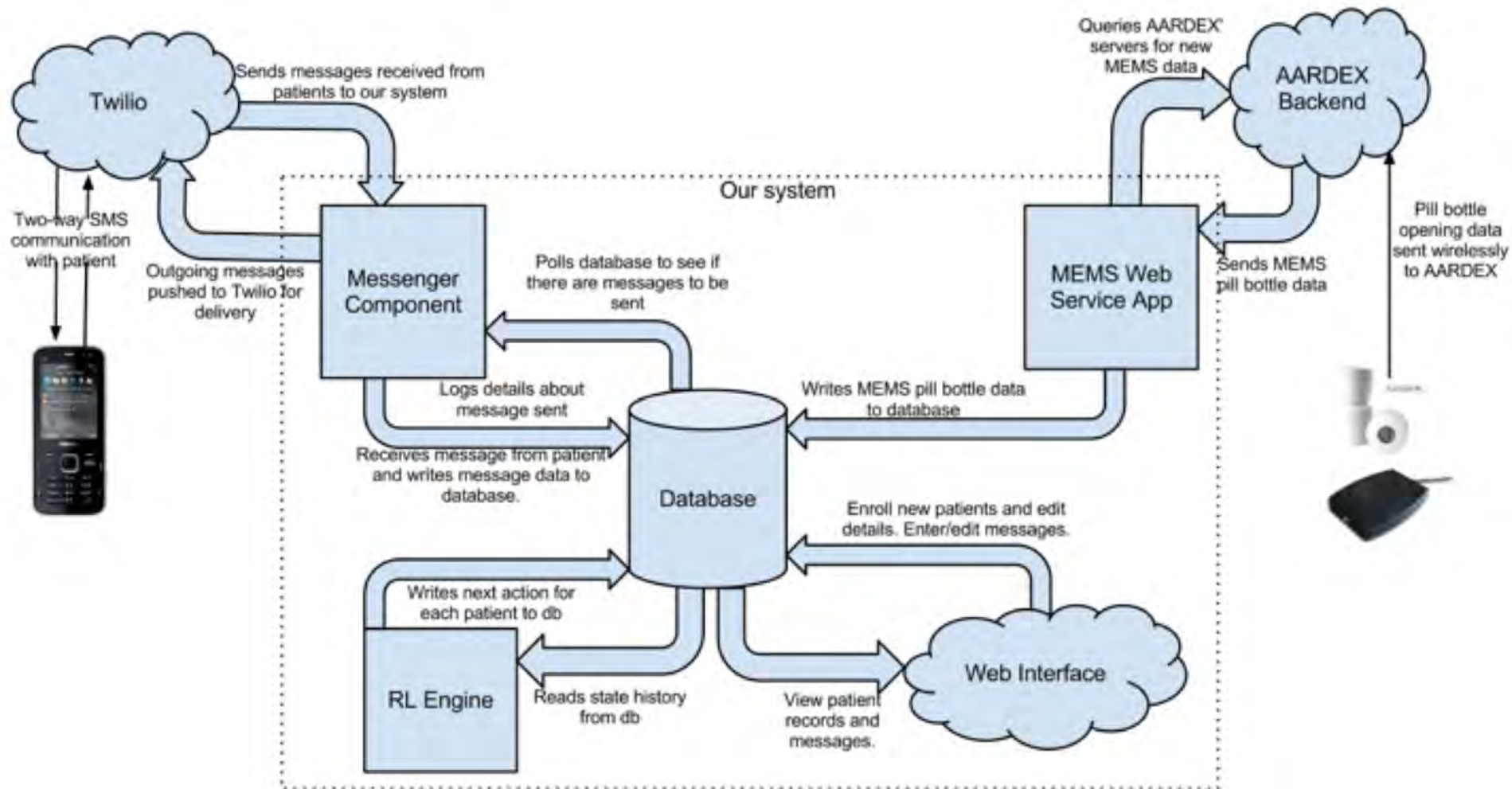
Study 1

Is it working?

Are messages adapting?



RL Medication Adherence System





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Pill Bottle Opening is the “Reward”



Types of Text Messages

DISEASE BELIEFS

1. The risk of having a stroke is 4 to 6 times higher in people whose blood pressure is not controlled.
2. High blood pressure can damage blood vessels in your eyes and lead to vision problems, including blindness.

MEDICATION NECESSITY

1. Blood pressure medication is one of the most effective ways you can take control of your health.
2. High blood pressure will damage your body unless you keep it under control with your blood pressure medicine.

MEDICATION CONCERNS

1. Some side effects are unpleasant at first but get better with time. Speak to your doctor if you are bothered by side effects.
2. If you have side effects, talk to your doctor about ways to make it better.

REMEMBERING STRATEGIES

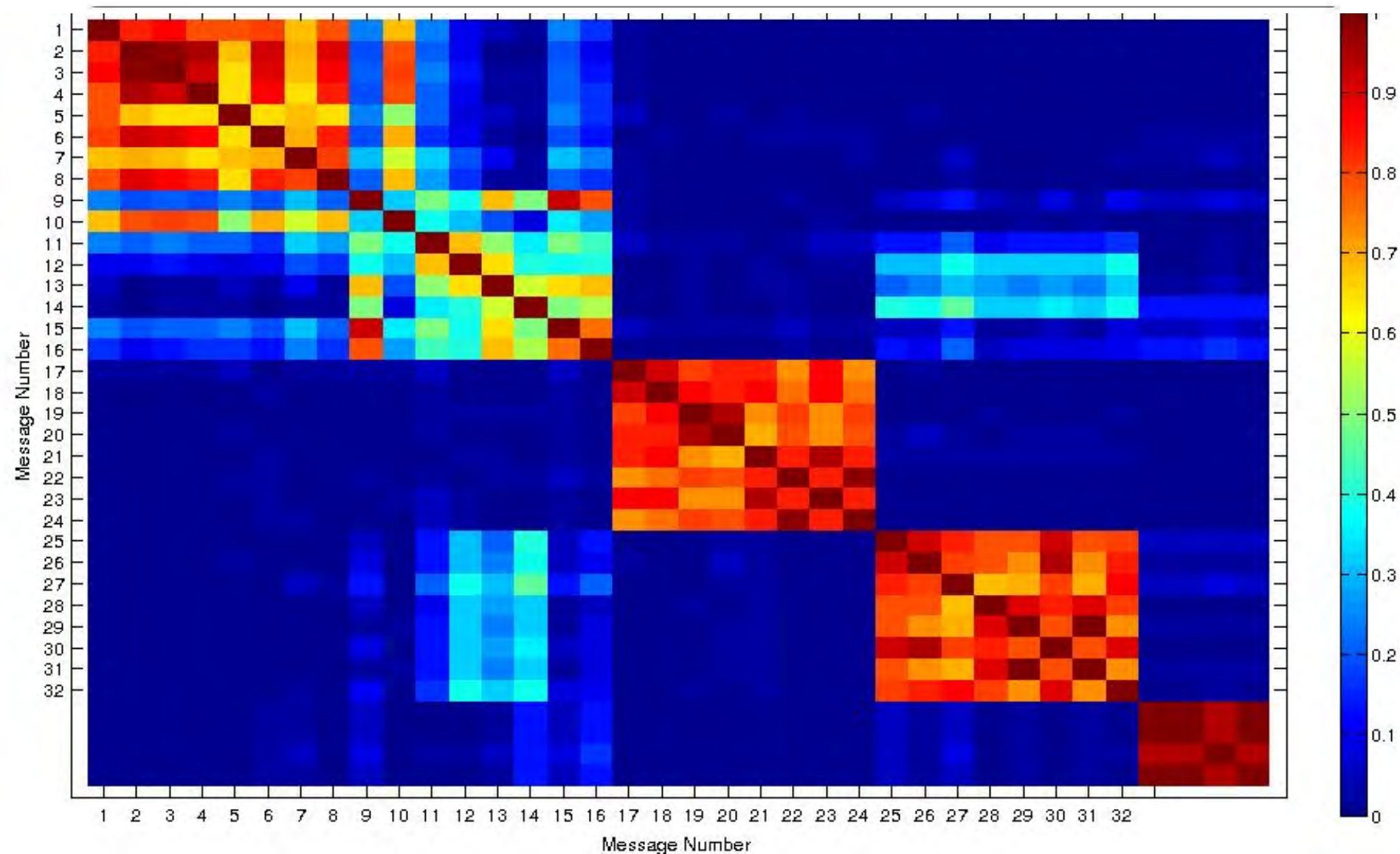
1. To help remember your BP medication, try putting your bottles near something you see every day, like your toothbrush.
2. Some people find it helpful to use an alarm on their mobile phone to remember to take medications.

POSITIVE REINFORCEMENT

1. Your BP meds....you're taking them. 😊
2. Good to see you're taking your BP meds.

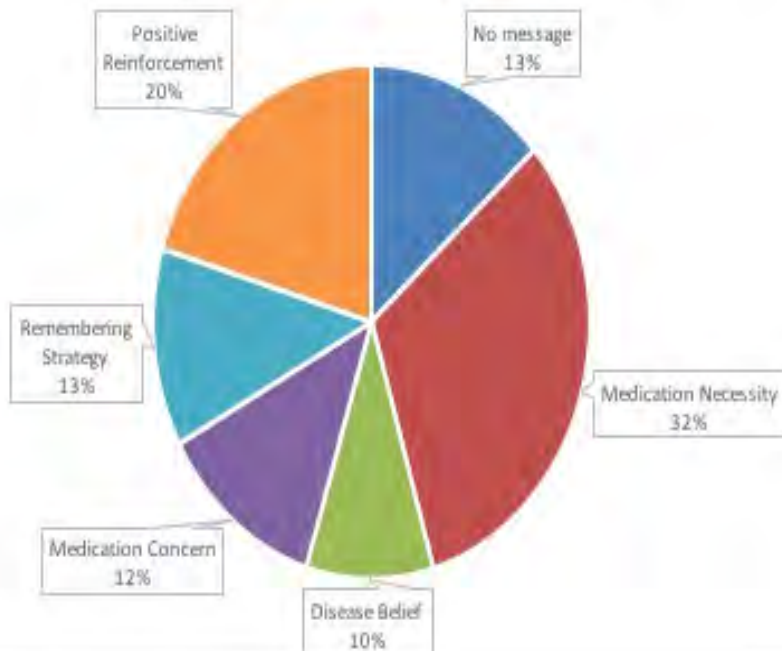


Message are Unique

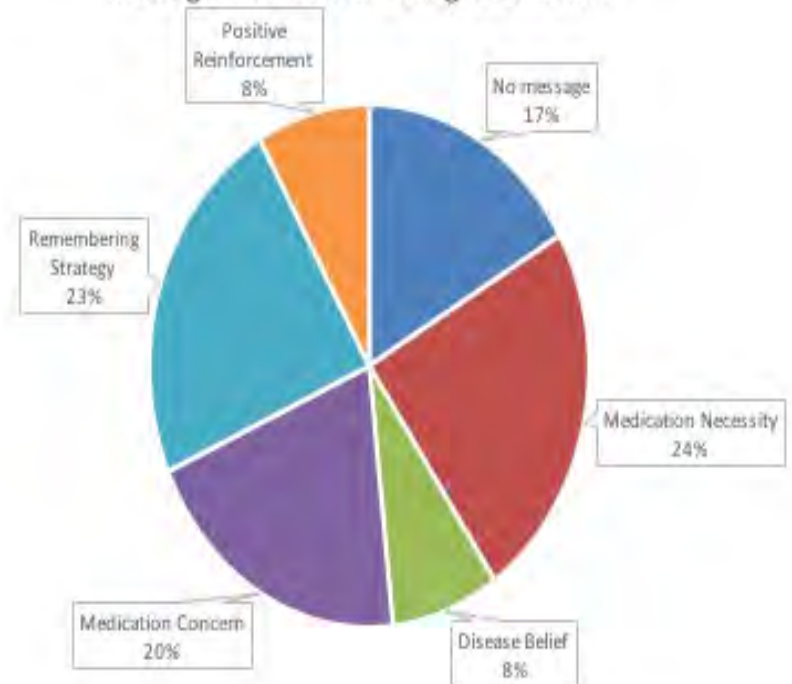


Study 1. Message Type Distribution

Message Distribution during Second Month



Message Distribution during Last Month



Study 2

Is it working?

Is adherence changing?

What do participants think?



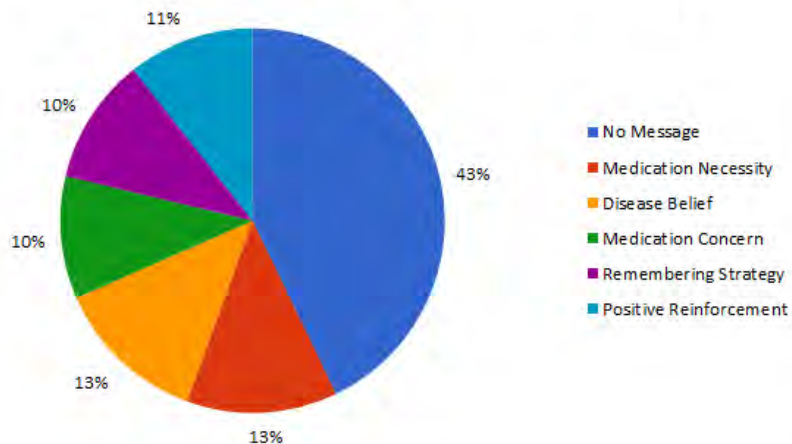
Baseline comparisons

	MEMS + Text n=23	MEMS only n=24
Age	54.9 (6.6)	55.5 (7.7)
Race (% white)	82.6%	91.6%
Education		
HS or less	30.4%	20.8%
Some college or more	69.6%	79.2%
Income¹		
Up to \$50,000	4.3%	4.2%
\$50,001 - \$100,000	56.5%	45.8%
> \$100,000	34.8%	45.8%
Health Literacy (% never need help reading instructions)	82.6%	83.3%
SR Adherence (% excellent)	69.6%	83.3%
SR Adherence (% excellent and very good)	83.3%	91.7%
PDC (previous 1 year)	0.38 (0.12)	0.41 (0.82)
¹ missing data		

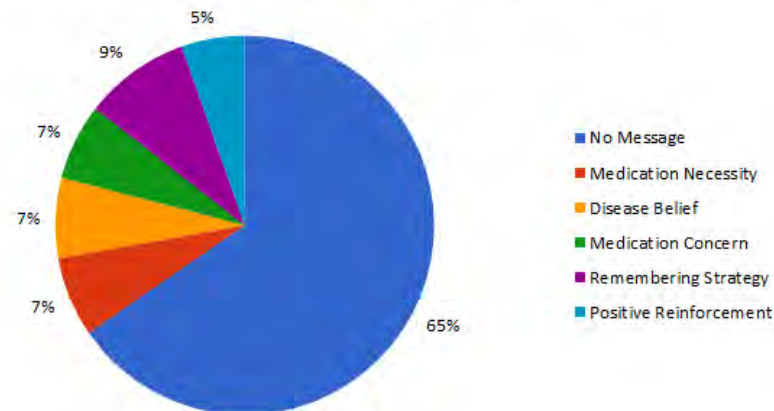


Study 2. Message Type Distribution

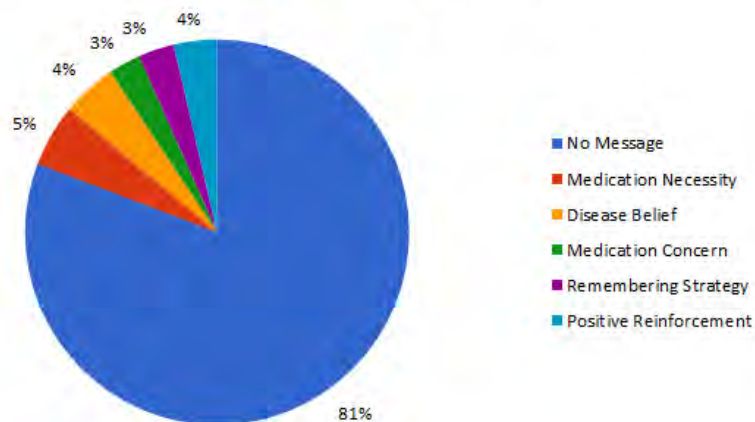
Message distribution during first month of learning



Message distribution during third month



Message distribution during sixth month



Monthly Pill Bottle Openings

Control

Month 1	Month 2	Month 3	Month 4	Month 5	Month 6
100%	96%	100%	100%	100%	100%
82%	93%	89%	79%	82%	79%
96%	100%	100%	100%	100%	100%
100%	100%	100%	100%	100%	100%
100%	100%	93%	100%	100%	100%
100%	100%	93%	100%	100%	100%
100%	100%	96%	100%	100%	100%
89%	86%	86%	89%	82%	89%
89%	89%	96%	86%	96%	89%
100%	93%	89%	96%	100%	100%
93%	89%	96%	89%	89%	86%
100%	100%	100%	89%	86%	100%
0%	0%	0%	0%	0%	0%
96%	96%	100%	100%	96%	100%
96%	93%	96%	100%	100%	100%
96%	100%	89%	18%	0%	0%
89%	96%	96%	100%	100%	100%
93%	100%	93%	100%	71%	39%
93%	93%	68%	75%	93%	75%
29%	89%	89%	71%	75%	79%
100%	93%	93%	93%	96%	100%
100%	89%	86%	82%	89%	96%
100%	93%	100%	82%	93%	86%
79%	86%	64%	39%	46%	57%

Messaging

Month 1	Month 2	Month 3	Month 4	Month 5	Month 6
100%	100%	100%	100%	96%	89%
100%	96%	93%	75%	71%	82%
100%	100%	100%	100%	100%	96%
89%	93%	79%	71%	61%	64%
100%	100%	100%	100%	100%	100%
36%	43%	29%	14%	14%	14%
100%	100%	79%	100%	100%	93%
100%	100%	100%	100%	96%	100%
100%	100%	100%	96%	89%	68%
100%	100%	100%	100%	86%	100%
100%	100%	100%	100%	100%	100%
100%	100%	100%	100%	100%	93%
100%	100%	93%	96%	93%	100%
100%	93%	96%	89%	93%	82%
100%	100%	96%	100%	96%	86%
100%	100%	100%	100%	75%	96%
100%	100%	100%	100%	86%	100%
100%	96%	96%	93%	100%	100%
100%	100%	100%	100%	100%	100%
100%	100%	93%	96%	100%	95%
100%	96%	100%	93%	93%	100%

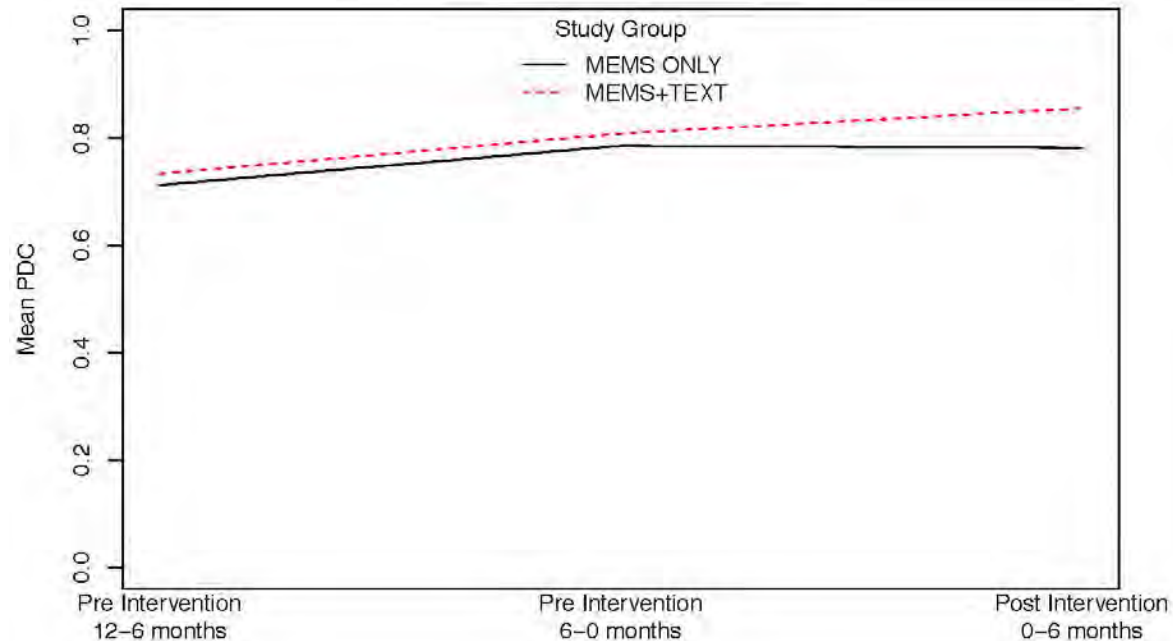
Comparison of Adherence Differences

	MEMS + Text	MEMS Only	
Adherence rating difference (E, VG, G, F, P)			
Baseline to 3 months	0 (1.1)	0.68 (1.0)	t = 2.04, p=0.04
Baseline to 6 months	0 (1.0)	0.36 (0.85)	t = 1.28, p=0.20

1-item SR Adherence (1=excellent, 5=poor), where a positive difference means higher/worse adherence at 3 or 6 months

PCD for Antihypertensive Medication by Group and Over Time

MEMS Cap Antihypertensive Drugs



	12-6 months prior	6-0 months prior	0-6 months after
MEMS Only	0.712 (± 0.257)	0.785 (± 0.204)	0.782 (± 0.287)
MEMS + Text	0.733 (± 0.295)	0.808 (± 0.268)	0.855 (± 0.191)

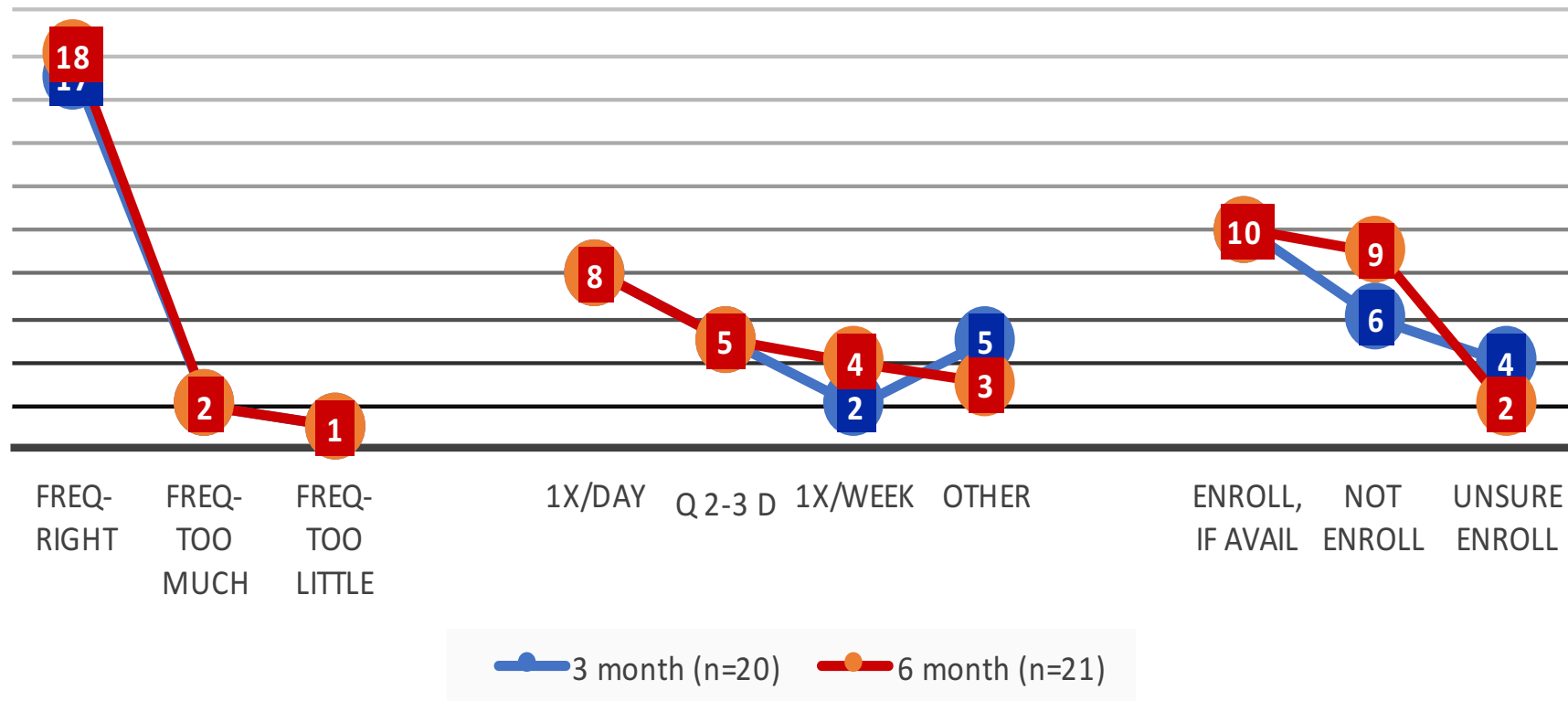


Table 2: Clustering of participants according to their response rates to message types

Study ID	Cluster	Overall Adherence Rate	Medication Necessity	Disease Belief	Medication Concern	Remembering Strategy
1	1	98%	92%	100%	92%	93%
15	1	99%	91%	100%	100%	94%
19	1	95%	88%	91%	93%	94%
24	1	99%	100%	100%	95%	93%
27	1	97%	92%	100%	90%	86%
30	1	92%	92%	88%	93%	94%
35	1	94%	94%	91%	95%	89%
37	1	96%	95%	92%	96%	95%
38	1	97%	94%	95%	100%	94%
41	1	96%	93%	94%	94%	96%
48	1	97%	93%	100%	89%	100%
5	2	84%	89%	77%	75%	83%
8	2	78%	80%	67%	88%	71%
6	3	100%	100%	100%	100%	100%
10	3	100%	100%	100%	100%	100%
20	3	100%	100%	100%	100%	100%
42	3	100%	100%	100%	100%	100%
11	4	32%	25%	29%	40%	38%
12	5	92%	100%	89%	83%	100%
17	5	92%	100%	87%	88%	94%
44	5	97%	100%	93%	92%	94%



Feedback from Participants Receiving Text Messages



Discussion

- RL agent adapts over time and its impact on non-adherence is mixed.
- An intervention to improve medication adherence needs to be delivered to individuals who are non-adherent.
 - Recruit via uncontrolled disease
 - Use for specialty medications
- A reward for the RL system that is embedded into daily life or is unobtrusive is needed.
 - Sensor report, e.g., number of steps
 - Clinical end point, e.g., BP reading
- Even with an RL system, the system can learn to send no message. Understanding “loading”, “daily” and/or “booster” doses of messages is needed.
- Continue to discern which messages work for which individuals...can a policy for the RL agent be determined?

Conclusions

- Text messaging improved self-reported adherence at 3 months but not at 6 months; pill bottle openings showed little variability.
- Adaptation of text messaging worked.
- One message per day or one every 2-3 days was generally preferred and about half of participants would enroll in a text-messaging service...same at 3 and 6 months.
- Next steps...place the RL system into a health plan or clinic setting and use an observational design; focus on high-cost specialty medications.

Co-Investigators

- John Piette, PhD, School of Public Health
- Sean Newman, MS, School of Public Health
- Satinder Singh, PhD, Department of Computer Science
- Larry An, MD, Medical School
- Vince Marshall, MS, College of Pharmacy

At the time of this work, the following individuals were employed by the College of Pharmacy:

- Peter Batra, MS, Institute of Social Research
- Teresa Salgado, PhD, VCU School of Pharmacy



Contact Information

Karen B. Farris, PhD

University of Michigan College of Pharmacy

kfarris@med.umich.edu





“Smart Pillbox” Transition Study

Jeffrey L. Schnipper, MD, MPH, FHM
Director of Clinical Research, BWH Hospitalist Service
Associate Physician, Division of General Medicine,
Brigham and Women’s Hospital
Associate Professor, Harvard Medical School





Outline

- Background
- Description of intervention
- Flow diagram
- Barriers to implementation
- Discussion: what would it take to make this part of usual care?
- Next steps and conclusion
- (Q+A after all 3 presentations)



Background

- Transitional period between inpatient and outpatient settings potentially dangerous time for patients, esp. re: medication safety.
- Adverse drug events after discharge are common and potentially serious. Due to:
 - Misunderstanding of medication regimen
 - Non-adherence
- Patient education has been less effective than expected when studied.

Coleman EA, et al. Ann Intern Med. 2004;141(7):533-536.

Coleman EA, et al. Arch Intern Med. 2005;165(16): 1842-1847.

Forster AJ, et al. Ann Intern Med. 2003;138(3):161-167.

Schnipper JL, et al. Arch Intern Med. 2006;166(5):565-571.

Kripalani S, et al. Ann Intern Med. 2012;157(1):1-10.

Osterberg L, et al. N Engl J Med. 2005;353(5):487-497.



“Smart pillbox”





“Smart Pillbox” Features

- Sends visual and audible med reminders.
- Senses if meds removed from each well.
- Enabled to send phone, text, email alerts to patients and/or caregivers if administration is delayed.
- Tracks and sends adherence data to PCP; link embedded in electronic health record.
 - Also available to pharmacist case manager.



Intervention Details

- First month of meds supplied by BWH outpatient pharmacy prior to discharge (“meds to beds”).
- Subsequent medication trays mailed to patient every 2-4 weeks by BWH or collaborating pharmacy, depending on patient’s insurance.
- Medications at risk for unexpected changes withheld from pillbox (e.g., warfarin), plus PRNs, opioids, other controlled substances.
- Pharmacist care manager calls patient if evidence of non-adherence (3 days in a row of < 80% adherence).
- Intervention lasts for 6 months – ensure patient has a “safe landing” back to usual pharmacy.



Study Goals

- Implement use of “smart pillbox” in transitional care setting.
- Evaluate effects of intervention on medication discrepancies, adherence, markers of chronic disease control.
- Determine barriers and facilitators to implementation.

Approved by BWH Primary Care Practice-Based Research Network



Design

- Inclusion criteria: Adult, English/Spanish-speaking patients admitted to BWH general medicine, cardiology, oncology teams, 5 or more chronic meds, discharge home, with BWH PCPs.
- Randomization by BWH PCP practice to 1) “smart pillbox”; 2) normal pillbox; 3) usual care.
 - 133 patients per arm.
- Outcomes followed for 6 months:
 - Discrepancies between documented and dispensed medications.
 - Medication adherence.
 - Measures of chronic disease control.
- Intervention January 2017 – June 2018.

Role of Inpatient Team in Intervention

- Perform discharge medication reconciliation and send prescriptions to BWH outpatient pharmacy as early in discharge process as possible.
- Send electronic message to PCP/specialist with planned outpatient regimen.
- Complete bedside medication delivery form.
 - Provide estimated date and time of discharge.
 - Note if any anticipated last-minute changes to discharge medication regimen.
 - Note if any medications should be withheld from the pillbox due to risk for unexpected changes.



Accessing Adherence Report

- Available from native screen in EHR.
- Provides link to adherence report log-in screen.
- Default log-in and password same as providers' EHR credentials where possible.

Viewing Adherence Report

By clicking dashboard, providers see a list of all patients who need outreach.

By scrolling down further, providers see a full list of their patients involved in the study.

My Profile

Dashboard

Signout

Patients Requiring Outreach

3-Day Compliance

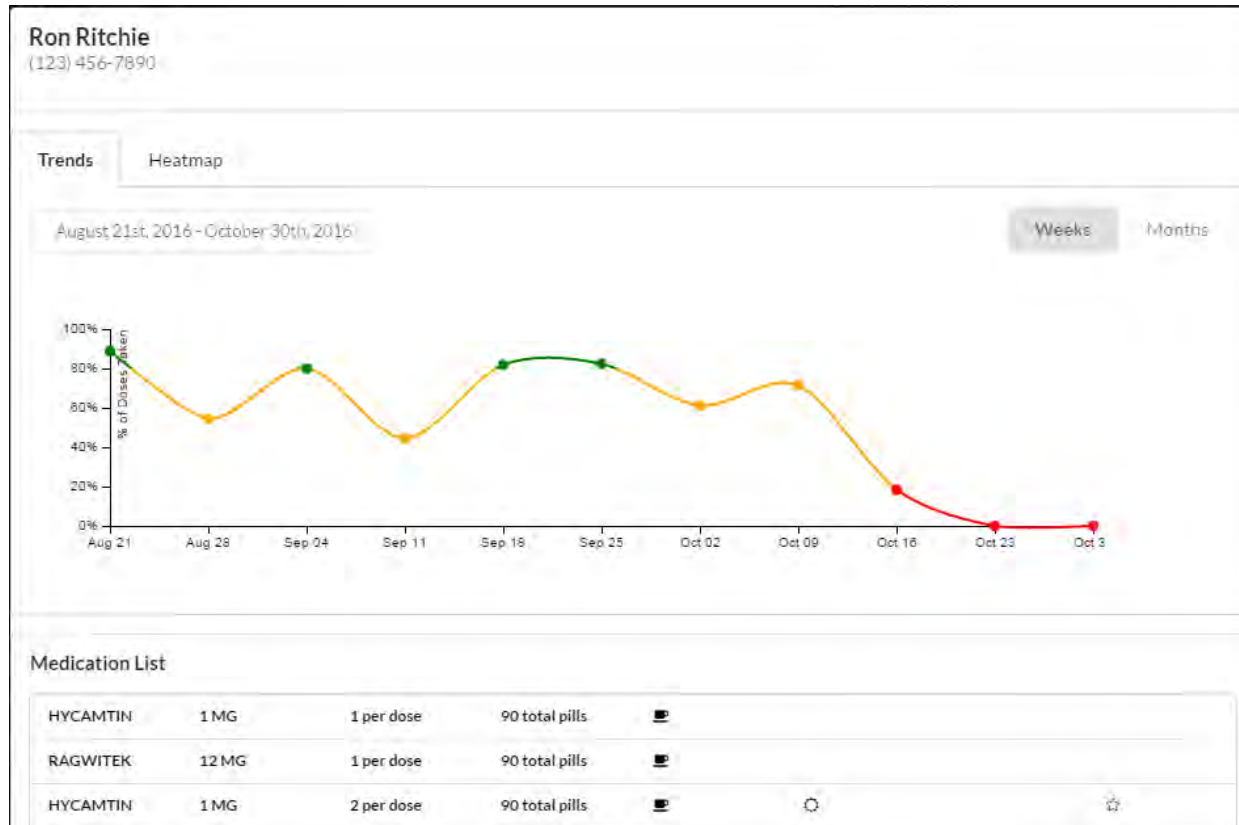
Filter Name...

<div>Tvh Test</div> <div>(301) 943-6475 (EDT)</div>	3 days with less than 80% compliance	<div><div></div></div> <div><div></div></div>
<div>Ron Ritchie</div> <div>(123) 456-7890 (EDT)</div>	3 days with less than 80% compliance	<div><div></div></div> <div><div></div></div>
<div>Celestine Cassin</div> <div>(123) 456-7890 (EDT)</div>	3 days with less than 80% compliance	<div><div></div></div> <div><div></div></div>
<div>Jermaine Kertzmman</div> <div>(123) 456-7890 (EDT)</div>	3 days with less than 80% compliance	<div><div></div></div> <div><div></div></div>
<div>Asia Rau</div> <div>(123) 456-7890 (EDT)</div>	3 days with less than 80% compliance	<div><div></div></div> <div><div></div></div>
<div>Marilou Harris</div> <div>(123) 456-7890 (EDT)</div>	3 days with less than 80% compliance	<div><div></div></div> <div><div></div></div>
<div>Dr. Herbert</div> <div>(123) 456-7890 (EDT)</div>	3 days with less than 80% compliance	<div><div></div></div> <div><div></div></div>



Adherence Report: Time Trends

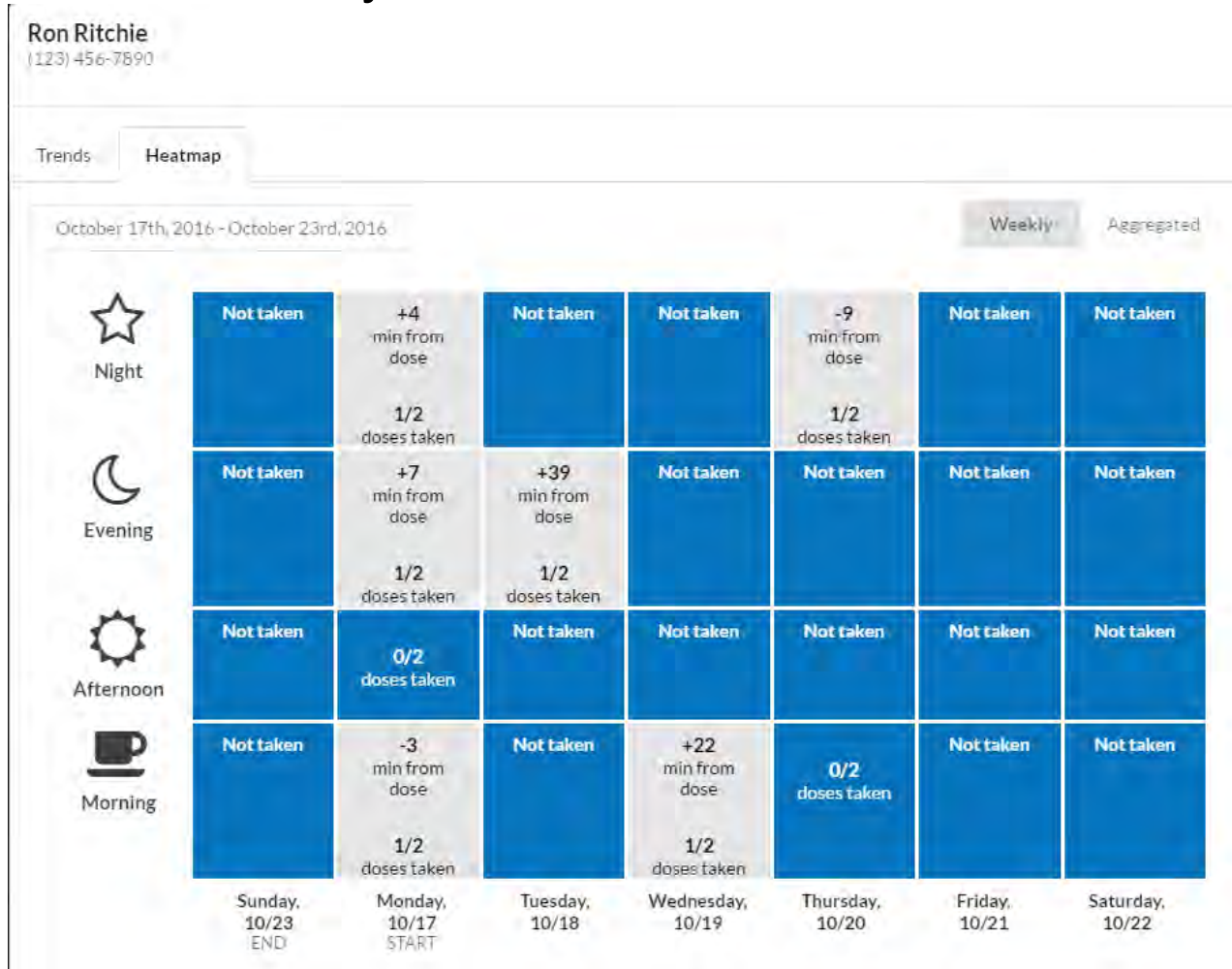
Clicking on a patient's name brings up a personal med summary



- The graph displays percent of doses taken over time.
- Users can adjust the time frame for the graph by clicking 'Weeks' or 'Months.'

Adherence Report: Dose Times

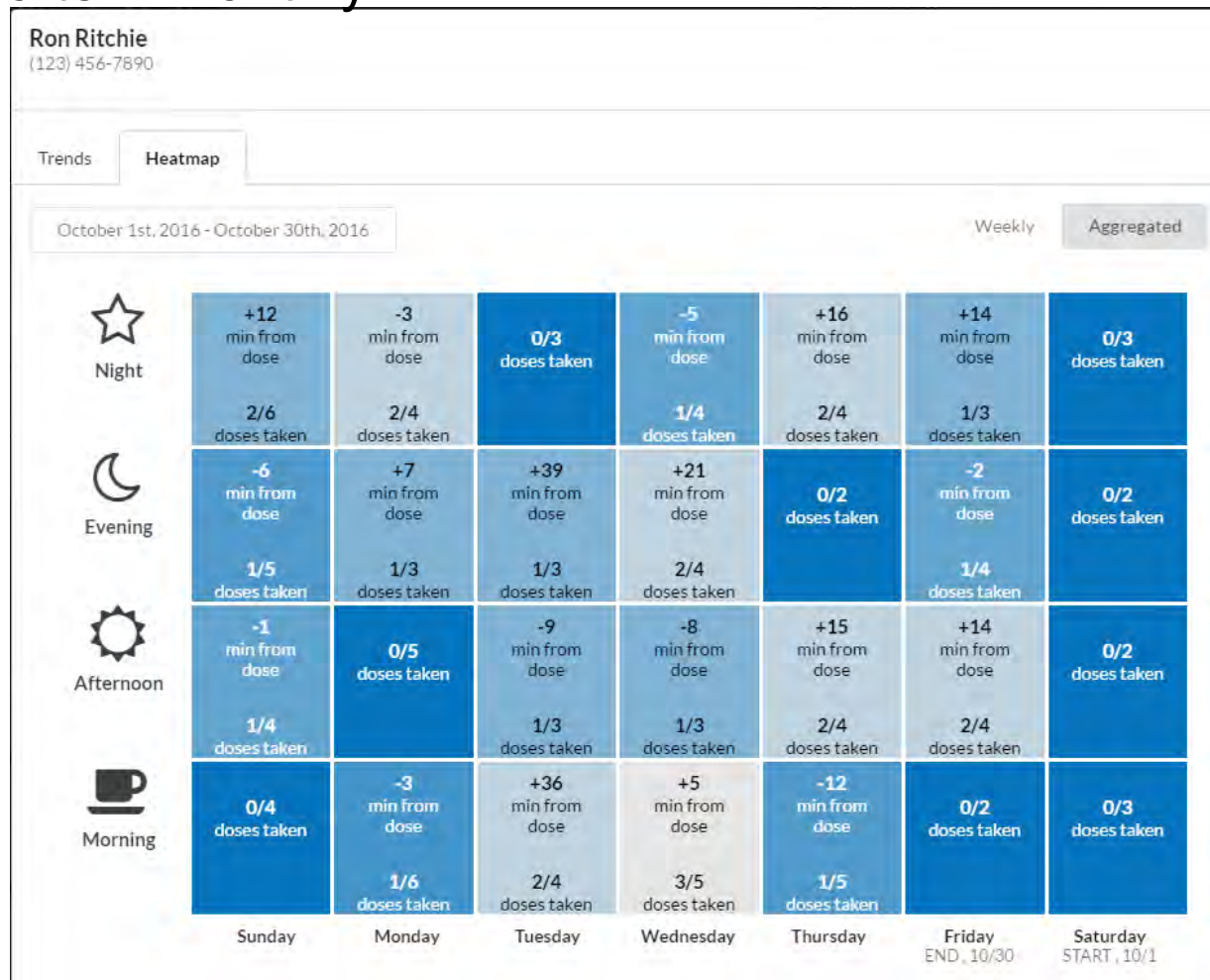
By clicking 'Heatmap,' providers see which doses are missed most often: weekly





Adherence Report: Dose Times

By clicking 'Heatmap,' providers see which doses are missed most often: monthly



Role of Outpatient Providers

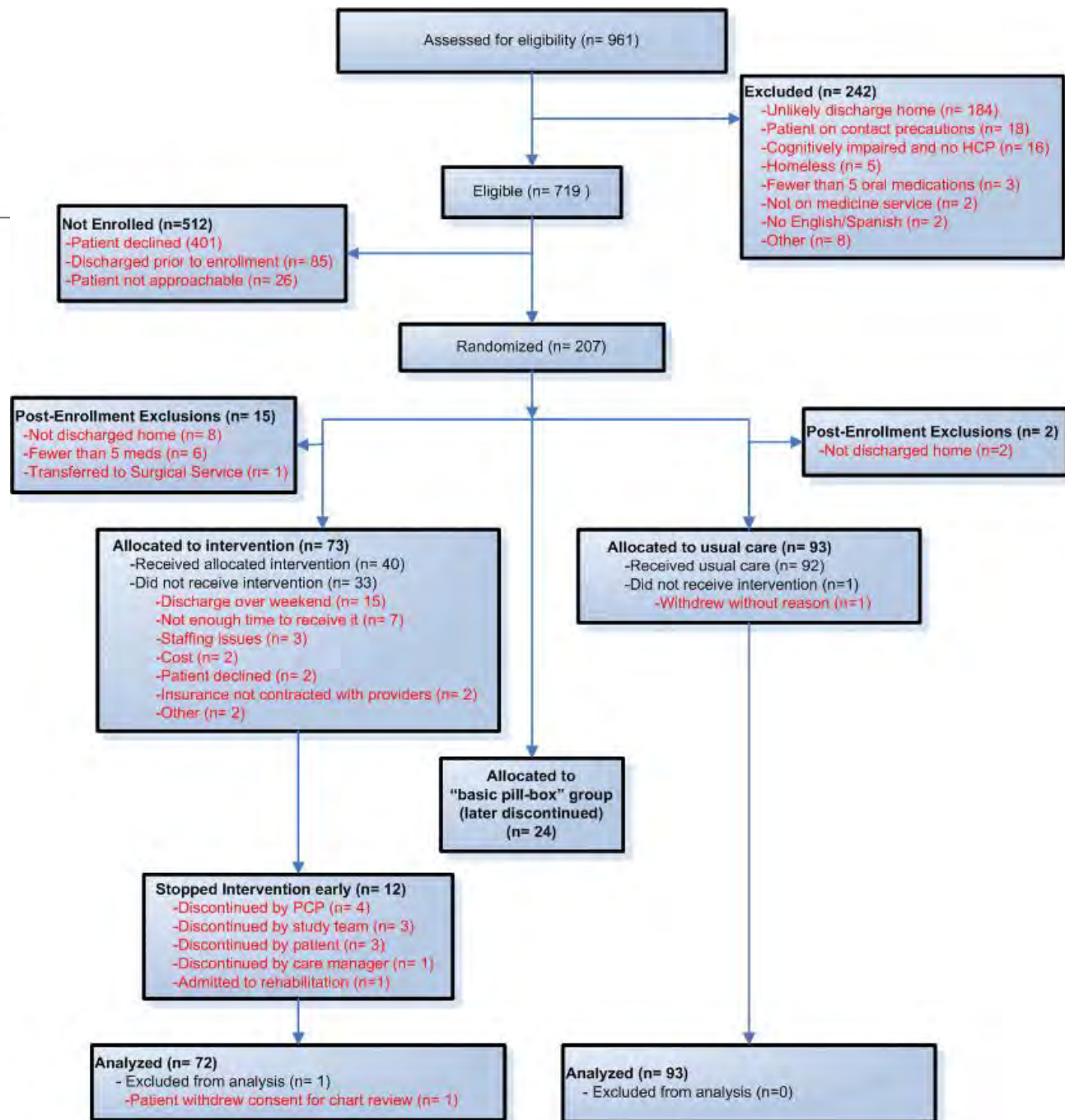
- Encouraged PCPs (or practice managers) to review the adherence reports periodically.
- If evidence of non-adherence, suggested they engage the patients as their practices see fit.
- If collaborating pharmacy reached out to the patient, they write a note which is added to patient's electronic chart.
- If discrepancies noted between EHR's and pillbox's medication lists, practices contacted to resolve them.

Outcome Assessment

- During 180 days after discharge
- Medication Discrepancies
 - Between filled prescriptions and active medication list in EHR
- Medication Adherence
 - Proportion of days covered (PDC)
 - Daily Polypharmacy Possession Ratio (DPPR)
- Disease control
 - Blood pressure, A1c, LDL cholesterol

Outcome Assessment

- Implementation in intervention arm patients.
 - Proportion of regimen in pill trays.
 - On-time delivery of trays.
 - Use of adherence reports by outpatient providers.
 - Documentation of action taken by providers in response to non-adherence.
- Qualitative analyses
 - Interviews of patients, inpatient providers, and outpatient providers.
 - Perceived effects on patient care and workflow
 - Barriers and facilitators of implementation
 - Suggestions for improvement



Barriers to Enrollment

Barriers During Patient Enrollment	Potential Solutions
Patient denial of previous problems with adherence.	Scripts to reduce stigma of accepting the intervention; engagement of patient's caregivers and providers.
Perceived portability issues with pillbox.	Educate patient that pills may be removed early in the day.
Too many medications dispensed outside of the pillbox.	Text reminders for non-pillbox medications; patient education re: using pillbox under different situations.
Potential for copayments to increase.	Emphasize that the benefits of the intervention may be worth the copay increase.
Resistance to participating in research studies.	Highlight potential benefits to patients and general public.

Barriers at Discharge

Barriers at Discharge

Potential Solutions

Turn-around time: pharmacy often receives prescriptions for patient <2 hours before anticipated discharge.

Encourage clinicians to provide prescriptions as early as possible; facilitate early communication between pharmacist and clinician.

Time required to dispense initial medications and enter information into pillbox application.

Develop pillbox software interface compatible with hospital's EHR and medication dispense system.

Outpatient pharmacy closed on weekends.

Developed protocol for patients discharged over the weekend to return on Monday to receive pillbox.

Lack of insurance coverage for early prescription refills.

Fund to cover costs; plan to engage insurance companies to allow for early refills.

Barriers After Discharge

Barriers Post Discharge

Potential Solutions

Difficulty reaching patients to confirm refills.

Attempt to reach through multiple methods in addition to phone calls.

Difficulty obtaining prescription refills from providers, especially if multiple prescribers per patient.

Procedures for obtaining refills from each practice and documenting usual prescriber for each medication.

Pillbox connectivity: poor signal in some locations.

Planned pillbox enhancements; optimizing location of the pillbox within the home.

Pillbox threshold for detecting removal of small pills.

Group medications for each dose if possible; planned pillbox enhancements to detect one small pill.

Discussion

- Could this intervention be part of usual care?
 - If no longer a study, several issues go away.
 - Resistance to participating in research.
 - Stigma and denial issues may or may not go away.
 - May help if intervention recommended by one's own providers.



Discussion

- Could this intervention be part of usual care?
 - Logistical issues were prominent, some could be resolved by “productization.”
 - Ensure compatibility of pillbox software with EHR and with medication dispense system.
 - Having multiple pharmacists who can program software and dispense blister packs.
 - Taking advantage of efficiencies of scale.
 - Would need more concerted effort to facilitate early communication between clinicians and pharmacists, provide prescriptions early.

Discussion

- Could this intervention be part of usual care?
 - Some logistical issues are harder to correct
 - Tension between time constraints to set up pillbox and the rush and unpredictability of hospital discharge.
 - Restricted hours of most hospital-based pharmacies make evening and weekend discharges challenging.



Discussion

- Could this intervention be part of usual care?
 - Some issues may require more systemic change.
 - Can insurance companies agree to a waiver of early refills and reduction in copayments to 90-day levels in exchange for using intervention?
 - Is there a sustainable business model for pharmacies to do the extra work?
 - If not, who pays for it?
 - Former pharmacies may object to loss of business.
 - Paradigm shift for patients and providers: regimen-based prescribing.



Discussion

- Could this intervention be part of usual care?
 - Some issues require iterative technological improvements.
 - Signal strength, pillbox connectivity
 - Threshold for detecting pill removal
 - Improving portability
 - Some patients may just not be ideal candidates for the intervention.
 - Is this the best time to initiate this intervention?
 - Pros and cons vs. stable ambulatory patients

Next Steps

- Complete interviews with patients, PCPs, inpatient providers.
- Complete outcome assessment.
- Work on dissemination activities.

Conclusions

- A smart pillbox has potential to decrease med discrepancies and improve adherence.
- Otherwise ideal candidates may resist this electronic intervention for a variety of reasons.
- Some patients may not be ideal candidates:
 - Frequent travel, nature of medication regimen
- Many patients are pleased with the service.
- Although logistically difficult, the potential benefits of this intervention during a high-risk period warrant further efforts to modify and refine discharge workflow.

Collaborators

- Harry Reyes
- Racquel DeCastro
- Jose Cruz Garcia
- Marcus Gresham
- Brain Levin
- Amrita Chabria
- Katie Czado
- Tamara Roldan
- Evan Shannon
- Rahul Jain
- Emily Cerciello
- Janan Dave
- Hareesh Ganesan
- Chelsea Brill
- Vicki Andros
- Tracey Stevens



Contact Information

Jeffrey L. Schnipper, MD, MPH, FHM
Brigham and Women's Hospital
Harvard Medical School

jschnipper@bwh.harvard.edu





Enhancing Clinical Decision Support Applications for Community Pharmacist- Delivered Medication Therapy Management

Margie E. Snyder, PharmD, MPH, FCCP
Purdue University College of Pharmacy

September 13, 2018

Study Aims

1. To evaluate the extent to which computerized CDS for community pharmacist-delivered MTM aligns with established human factors principles.
2. To assess the *usability* of MTM CDS for community pharmacists, as well as pharmacists' *perspectives* on the usefulness and usability of these technologies for patient care.

Contact Information

The complete presentation will be posted in several months following article publication. Those interested may contact the Principal Investigator for more information:

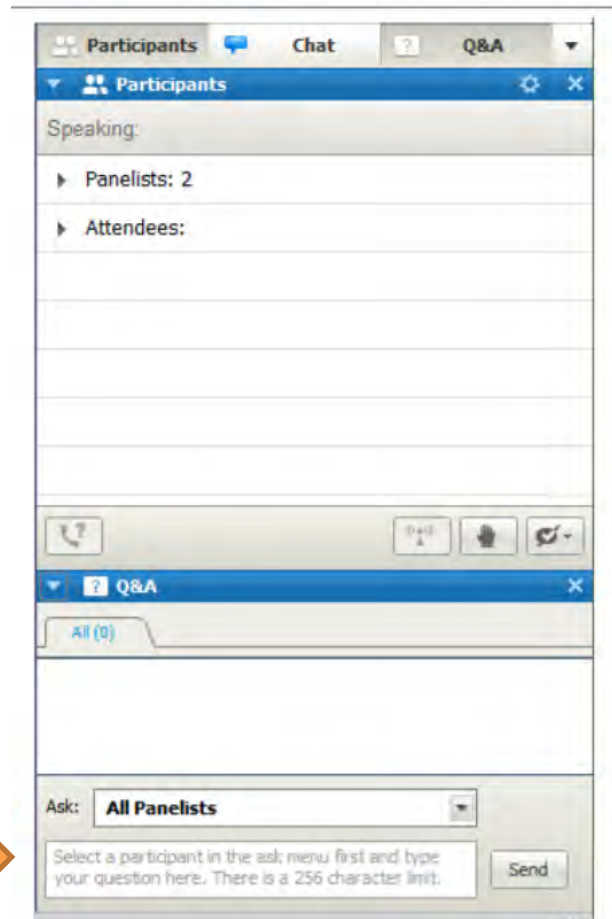
Margie E. Snyder, PharmD, MPH, FCCP
Purdue University College of Pharmacy
snyderme@purdue.edu



Questions

How to Submit a Question

- At any time during the presentation, type your question into the “Q&A” section of your WebEx Q&A panel.
- Please address your questions to “All Panelists” in the drop-down menu.
- Select “Send” to submit your question to the moderator.
- Questions will be read aloud by the moderator.





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